NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
51 HOVEY ROAD, PENSACOLA, FL 32508-1046

NAMRL-1413

DIGITAL ANTHROPOMETRIC VIDEO-IMAGING DEVICE (DAVID) VERSUS ANTHROPOMETRIC MEASUREMENTS

J.L. Saxton, C.L. Lords, and F.R. Patterson

ABSTRACT

Anthropometric data are essential in the development and design of items in industry, transportation, and housing. Anthropometry is particularly important in military aviation due to restrictive environments found in cockpits and the limited range of motion allowed for safe operation of controls. Methods of obtaining anthropometric measurements are varied. They range from manual techniques, such as tape measures and calipers to three-dimensional whole-body scanners. In addition to these methods, a computer-based technique called the digital anthropometric video-imaging device (DAVID) has been developed at the Naval Aerospace Medical Research Laboratory, in Pensacola, Florida. The DAVID provides a means to capture and measure a person's digital image using off-the-shelf hardware and software. A study comparing 6 anthropometric measurements (sitting height, sitting eye height, sitting acromial height, thigh clearance, buttock-knee length, and sitting knee height) was completed on 236 aviation candidates (200 males and 36 females) using both the DAVID and manual (anthropometer) measurement methods. The mean data measurements compared favorably with data reported in previous anthropometric surveys. The results of this study indicate the DAVID technology provides comparative results to standard manual methods for the measurements tested.

Acknowledgments

The authors wish to acknowledge the assistance of the late Mr. Peter Collyer. Both HM3 Heather Woods and Ms. Meredith Walsh provided critical support in completing the measurements required for this project. The authors also wish to thank Ms. Kathy Mayer for her help in editing the manuscript.

INTRODUCTION

Accurate, reproducible anthropometric data are critical in many areas of our lives including the garment industry, transportation, furniture design, housing, and the workplace. The digital anthropometric video-imaging device (DAVID) was developed as an alternative to existing anthropometric measuring methods. Historically, anthropometric survey data were acquired using manual methods that required tape measures, anthropometers (calipers), and assorted devices (1,5-11,14,16,21). Recent developments include the use of laser or visible light technologies (2-4,12,13,15,17,20) to produce three-dimensional (3-D) scans of part or all of the subject. Another method used by the U.S. Navy to screen aviation candidates is a chair device, called the integrated anthropometric device (IAD), which permits measurement of linear anthropometric distances important to naval aviation (19).

The DAVID uses off-the-shelf software and hardware to digitally acquire and measure a subject's image. Compared with manual techniques, most of the DAVID's advantages are because it is computer based. These advantages include electronic storage of the images/measurements, electronic transfer of the data into other software packages (motion analysis, database, etc.), and file retrieval for quality control review.

We compared measurements using the DAVID and a standard manual technique incorporating anthropometers. The measurements evaluated in this study were sitting height, sitting eye height, sitting acromial height, thigh clearance, buttock-knee length, and knee height. Subjects were placed in a standard pose for each respective measurement. During this positioning, DAVID images were acquired and manual measurements were completed.

Direct comparison of the DAVID method with an accepted manual method is important because previous anthropometric surveys were completed using these standardized manual techniques (1,5,6,8-10,16). Design of current military aircraft is based on anthropometric data from these surveys.

METHODS

Volunteer subjects were recruited from a pool of medically screened aviation candidates awaiting training. The pool was made up of individuals from Officer Candidate School, the Naval Academy or Air Force Academy, Reserve Officer Training Corps (ROTC), and current active duty military personnel redesignated from other fields. We measured 200 males and 36 females.

Subjects reported in physical training gear (shirt, shorts, and shoes). For anthropometric measurements, subjects removed their shoes. To enhance the sitting acromial height measurement, male subjects removed their shirts and females rolled up their sleeves to expose their shoulders. Subjects were also asked to smooth out excess material in the legs of their shorts to improve the ability to delineate limits for the thigh clearance measurement. Although weight was not one of the parameters evaluated in this study, a Pelouze® Model 4040 platform balance (Evanston, IL) was used to obtain each subject's weight; values were recorded manually.

Manual measurements were based on procedures used for previously reported anthropometric surveys (1,5,6,8-10,16) as detailed in the appendix. The order of manual measurements was sitting height, sitting eye height, acromial height, thigh clearance, buttock-knee length, and knee height. All manual measurements were taken with GPM anthropometers (Seritex, Inc. Carlstadt, NJ). These instruments were graduated to 0.1 cm with major marks at each 0.5-cm increment. All six people taking measurements had completed formal anthropometric measurement training[1] or received on-the-job training. Each measurement trial was under the supervision of someone who had received formal training.

The DAVID consisted of a computer, camera, image acquisition hardware/software, and digitizing software. The computer system was a Gateway® P5-200 (Gateway 2000, North Sioux City, SD), with miroVideo® DC30 capture board (miro Computer Products, Inc., Palo Alto, CA), and Corel Draw® (Corel Corporation, Ottawa, Ontario, Canada) digitizing software. Digital images were integrated using JVC® model TK1070U (JVC Corp., Elmwood Park, NJ) color video cameras (with black-and-white mode selected).

[1] A Short Course in Anthropometry, Anthropology Research Project, Yellow Springs, Ohio, continuously offered.

The DAVID method involved acquiring and importing a seated side-view image into the analysis software. Due to the number of measurements necessary, a duplicate of the image was created to enhance the ability to discriminate each measurement. The first copy was used for sitting height, sitting eye height, acromial height, and thigh clearance measurements, while buttock-knee length and knee height were completed on the second copy. A template was designed to reflect this format on the final report/file. As an image was acquired, it was copied simultaneously into the appropriate location of the template. The final file contained completed measurements overlaid on the images.

The subject-to-camera distance was calibrated by adjusting the "world distance" of the Corel Draw® software. This calibration procedure involved placing an anthropometer, set to a known dimension, at a predetermined distance from the camera. The calibrated distance was equivalent to the distance from the camera to the right shoulder and thigh. The world distance value was set to give the same value as on the anthropometer.

Subjects sat on a table of sufficient height so their feet did not touch the floor. A height-adjustable footstool was used to position the subject's feet at the proper height. Subjects were also seated with their backs against a 6-in high "backboard" installed on the table. A piece of tape on the top of the table identified the plane used for the calibration. Subjects were seated such that their 1) right leg was in the calibration plane, 2) head was placed in a Frankfort plane position (see the appendix for definition), 3) arms were hanging naturally from their shoulders, 4) elbows were bent at 90 deg, 5) legs were perpendicular to the table, and 6) thigh axis was parallel to the floor. After positioning, the anthropometer arm was placed at the top of the subject's head. The DAVID image was acquired and stored (for later analysis), and manual measurements were then completed.

The image was saved with a numeric-sequence file name that included an assigned three-digit subject number and age. Additionally, the file name included numerical codes for sex, branch of service, student status, and aviation classification. The measurements were either completed immediately or at a later time by retrieving the appropriate file containing the stored images.

The procedure for completing measurements involved delineating the specific area to be measured using mouse operations. Body landmarks (see appendix) were used to define the measurements for the DAVID. To complete each measurement, DAVID operators placed a mouse cursor at one of the landmarks for the measurement; the left mouse button was depressed to mark the beginning of the measurement. The cursor was then moved to the opposite limit of the distance to be measured. Again, the left mouse button was depressed, and the software drew a line representing the distance of the measurement. The Corel Draw® software (using the world distance as a calibration factor) automatically calculated the linear distance of the line and placed a numeric value on the image adjacent to the line. Corresponding manual measurement values were unknown to DAVID operators.

The data reported for sitting height and sitting eye height were offset by a constant calibration value that corrected for the difference between the calibration plane and the plane in which the measurement was made. For example, the camera was calibrated for the lens-to-subject distance for the subject's right leg (right shoulder). The distances to the right side of the face for sitting eye height and the center of the head for sitting height measurements were greater than calibration distance at the right shoulder. Offset values were derived empirically by comparing the difference between means of the first 100 DAVID measurements with means of the manual measurements. The values derived were used for the remaining DAVID measurements.

RESULTS

Tables 1 and 2 (males and females, respectively) list the mean, standard deviation, minimum, and maximum values for both DAVID and manual measurements. All values are reported with the English system first and the metric values in parenthesis. Paired *t* tests were completed for each measurement comparing the manual and DAVID data.

Tables 3 and 4 compare data obtained in this study with that of previous anthropometric surveys (6,8,10,11) using manual measurement techniques. Raw data were not available for these surveys, but the results appear to be comparable with this study.

Table 1. DAVID/manual mean, standard deviation, minimum and maximum value comparison for males ($n = 200$). Weight in pounds (kg in parentheses), all other measurements are in inches with centimeters in parentheses.

Measurement	DAVID /Manual	Mean		Standard Deviation		Minimum		Maximum	
Weight		175.5	(79.7)	21.2	(9.7)	120.2	(54.6)	238.3	(108.2)
Sitting height	D	36.1	(91.7)	1.2	(3.1)	32.9	(83.5)	39.5	(100.4)
	M	36.1	(91.7)	1.3	(3.2)	32.5	(82.6)	39.7	(100.9)
Sitting eye height	D	31.3	(79.6)	1.1	(2.9)	28.2	(71.6)	34.6	(88.0)
	M	31.3	(79.5)	1.1	(2.8)	28.3	(71.9)	34.6	(88.0)
Acromial height	D	23.7	(60.2)	1.1	(2.8)	20.6	(52.3)	27.0	(68.6)
	M	23.7	(60.3)	1.1	(2.8)	20.9	(53.2)	26.8	(68.1)
Thigh clearance	D	6.9	(17.4)	0.5	(1.3)	8.1	(12.7)	7.8	(20.5)
	M	6.9	(17.6)	0.4	(1.1)	5.4	(13.7)	8.1	(20.7)
Buttock-knee length	D	24.3	(61.7)	1.1	(2.9)	20.9	(53.1)	27.9	(69.6)
	M	24.4	(61.9)	1.1	(2.8)	21.0	(53.4)	27.4	(69.6)
Knee height	D	21.5	(54.5)	1.1	(2.8)	18.7	(47.6)	24.4	(62.1)
	M	21.6	(54.8)	1.1	(2.7)	18.9	(48.1)	24.8	(62.9)

Table 2. DAVID/manual mean, standard deviation, minimum and maximum value comparison for females ($n = 36$). Weight in pounds (kg in parentheses), all other measurements are in inches with centimeters in parentheses.

Measurement	DAVID /Manual	Mean		Standard Deviation		Minimum		Maximum	
Weight		135.4	(61.5)	13.9	(6.3)	109.2	(49.6)	171.3	(77.8)
Sitting height	D	34.2	(86.8)	1.2	(3.0)	31.5	(80.0)	35.9	(91.2)
	M	34.2	(86.9)	1.3	(3.2)	31.6	(80.3)	36.1	(91.8)
Sitting eye height	D	29.7	(75.4)	1.3	(3.2)	26.8	(68.1)	31.6	(80.2)
	M	29.6	(75.3)	1.3	(3.3)	26.8	(68.1)	32.0	(81.4)
Acromial height	D	22.6	(57.5)	1.1	(2.8)	20.6	(52.3)	24.7	(62.7)
	M	22.9	(58.1)	1.1	(2.8)	20.7	(52.5)	24.7	(62.8)
Thigh clearance	D	6.2	(15.8)	0.4	(1.0)	5.3	(13.4)	7.3	(18.6)
	M	6.3	(15.9)	0.4	(1.0)	5.3	(13.5)	7.3	(18.5)
Buttock-knee length	D	22.6	(57.3)	0.8	(2.0)	20.8	(52.8)	24.3	(61.7)
	M	22.8	(58.0)	0.9	(2.3)	21.3	(54.0)	24.9	(63.3)
Knee height	D	19.6	(49.9)	0.9	(2.3)	17.6	(44.8)	21.3	(54.1)
	M	19.8	(50.2)	0.9	(2.2)	17.7	(45.0)	21.5	(54.6)

Table 3. Male anthropometric measurement comparison of 50th percentiles (weight in lbs; all other measurements in inches).

Measurement	NAMRL		Previous Data[a]		
	DAVID $n = 200$	Manual $n = 200$	1950 $n = 4060$	1964 $n = 1549$	1988 $n = 1774$
Sitting height	35.0	36.2	36.0	36.3	36.0
Sitting eye height	31.2	31.3	31.5	31.5	31.2
Sitting acromial height	23.6	23.7	23.3	23.8	23.5
Thigh clearance	6.8	6.9	5.6	[b]	6.6
Buttock-knee length	24.7	24.3	23.6	24.1	24.2
Sitting knee height	21.1	21.6	21.7	21.8	22.0
Weight	173.9	173.9	161.9	171.1	171.3

[a] From references 11,8,and 10
[b] Measurement not included in study

Table 4. Female anthropometric comparison of 50th percentiles (weight in lbs; all other measurements in inches).

Measurement	NAMRL		Previous Data[a]	
	DAVID $n = 36$	Manual $n = 36$	1977 $n = 1331$	1988 $n = 2208$
Sitting height	33.0	34.4	32.7	33.5
Sitting eye height	29.0	29.6	29.0	29.1
Sitting acromial height	22.9	23.1	[b]	21.9
Thigh clearance	6.2	6.2	6.1	6.2
Buttock-knee Length	22.5	22.6	22.7	23.1
Sitting knee height	19.7	19.7	20.6	20.3
Weight	135.9	135.9	[b]	135.0

[a] From references 16 and 10
[b] Measurement not included in study

DISCUSSION

The manual method was chosen for comparison because it was the technique employed in previous anthropometric surveys (1,5,6,8-10,16). It has proven to be an accurate method for obtaining anthropometric measurements when collected by well-trained technicians. Training must include instruction in positioning of the subject, identifying specific anatomical areas to be measured, aligning the anthropometer properly, and applying the correct amount of pressure while making the measurement. Accurate, reproducible measurements require constant attention to each of these areas by the technician completing the measurements.

The DAVID system is the result of several developmental evolutions. One of the most important improvements prior to this study was using Corel Draw® to complete the measurement. By a series of operations using the mouse, the operator could delineate the distance to be measured, and a calibrated distance with lines showing the limits of

the measurement would be overlaid on the image. Corel Draw® enabled an automated method for obtaining measurements.

The comparative data indicate the DAVID technology is capable of completing anthropometric measurements important in aviation as accurately as those obtained using an existing manual method. Because the DAVID is computer-based, the potential for improving anthropometric screening of naval aviation candidates is substantial. The only requirement to complete anthropometric measurements using the DAVID is to capture the subject's image; the measurement can be completed directly on the image. The results of the DAVID measurements can be imported electronically into other modeling, analysis, or database software and used to generate a report. One of the advantages of the DAVID data format is the file contains not only the measurements, but also exactly how the person was positioned and how each measurement was made. This file format facilitates review of files for quality control, mishap investigation, or any other reason.

Since this study, the DAVID system has been further improved by image acquisition hardware/software capable of software-selectable multiple camera inputs and image-analysis. The new software allows calibration or each measurement in both horizontal and vertical planes. Additionally, different cameras with zoom lenses have greatly improved the quality of the images. These refinements have enhanced the resolution, image quality, and measurement accuracy compared to the system described in this study. Even so, the overall concept of the DAVID remains the same.

REFERENCES

1. *Anthropometry and Mass Distribution for Human Analogues Vol. I: Military Male Aviators*, Joint Report: AAMRL-TR-88-010, NAMRL-1334, NADC-88036-60, NBDL 87R003, USAFSAM-TR-88-6, and USAARL 88-5; Tri-service Committee of the Tri-service Aeromedical Research Panel, Ft. Rucker, AL, 1988 Mar. (AD A197 650)

2. Bhatia G. *Whole Body Surface Scanner for Design of Protective Equipment*, Chesterfield, MO: Rose Imaging, Inc.; 1993 Dec, Report No.: AL/CF-TR-1994-0034.

3. Brooke-Wavell K, Jones PRM, and West GM. Reliability and Repeatability of 3-D Body Scanner (LASS) Measurements Compared to Anthropometry, *Annals of Human Biology 21*(6):571-577,1994.

4. Burnsides DB, Files PM, and Whitestone JJ. Integrate 1.25: *A Prototype for Evaluating Three-Dimensional Visualization, Analysis and Manipulation Functionality* (U), Dayton, OH: Sytronics, Inc.; 1996 May, Report No. AL/CF-TR-0095.

5. Chandler RF. *Uniform Mass Distribution Properties and Body Size Approximation for the 50 Percentile Male Aircrewmember During 1980-1990*, Oklahoma City, OK: Protection and Survival Laboratory, 1981, Federal Aviation Administration, Report No. AAC-119-81-4.

6. Churchill E, Churchill T, McConville JT, and White RM. *Anthropometry of Women of the U.S. Army-1977 Report No. 2- The Basic Univariate Statistics*. Yellow Springs, OH: Webb Associates, Inc.; 1977 June, Report No. NATICK/TR-77/024.

7. Daniels GS. *The "Average Man"?*, Wright-Patterson AFB, OH: Wright Air Development Center; 1952 Dec, Technical Note: WCARD 53-7.

8. Gifford EC, Provost JR, and Lazo J. *Anthropometry of Naval Aviators-1964*. Philadelphia, PA: US Naval Air Engineering Center; 1965 Oct, Report No. NAEC-ACEL-533.

9. Gill PHR. *Anthropometry Handbook*, Brooks Air Force Base, TX: USAF School of Aerospace Medicine; 1986 Feb, Report No. USAFSAM-TR-85-108.

10. Gordon CC, Churchill T, Clauser CE, Bradtmiller B, McConville JT, Tebbetts I, and Walker R. *1988 Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics*, Yellow Springs, OH: Anthropology Research Project, Inc.; 1989 Sep, Report No. NATICK/TR-89/044.

11. Hertzberg THE, Daniels GS, and Churchill E. *Anthropomery of Flying Personnel-1950*. Wright-Patterson AFB, OH: Aero Medical Laboratory, 1952, Sep, WADC Technical Report: 52-321.

12. Jones PRM, Baker AJ, Hardey CJ, and Mowat AP. Measurement of Body Surface Area of Children with Liver Disease by a Novel Three-Dimensional Scanning Device. *European Journal of Applied Physiology 68*:514-518, 1994.

13. Jones PRM, West GM, Harris DH, and Read JB. The Loughborough Anthropometric Shadow Scanner (LASS), *Endeavour, New Series 13*(4):162-168, 1989.

14. Khandkar SM, MacDonald CAH, Beevis D, and Noy I. *Clothed Anthropometry in the Canadian Forces Using Direct and Photogrammetric Methods*, Downsview, Ontario: Defence and Civil Institute of Environmental Medicine; 1980 Sep, Report No. 81-R-04.

15. Kline Y and Whitestone JJ. *An investigation of the Usefulness of 3-D Digitized Facial Images for the Issuance of the MCU–2/P Protective Mask*. Cherry Hill NJ: Arkline Research; 1995 Mar, Report No. AL\CF-TR-1995-0162.

16. Ludach LL, McConville JT, Churchill E, and White RM. *Anthropometry of Women of the U.S. Army-1977.* Report No. 1- Methodology and Survey Plan. Yellow Springs, OH: Webb Associates, Inc.; 1977 Jun., Report No. NATICK/TR-77/021.

17. *McLean MLS and Newsom B, Extraction* of Garment Manufacturing Data from 3D Whole Body Scans. Baltimore MD: HAAS Tailoring Co.; 1998 Feb, Report No. ADA347501.

18. Naval Air Systems Command. *Anthropometric Accommodation in Naval Aircraft*, NAVAIRINST 3710.9B, 1987.

19. Provost JR and Gifford EC. *Aerospace Crew Equipment Laboratory Problem Assignment No. CO4AE13-6-Part 2- Analysis of Anthropometric Data on Naval Aviators-The Integrated Anthropometric Device in Naval Aviation.* Philadelphia PA: U.S. Naval Air Engineering Center; 1964 Jan, Report No. NAEC-ACEL-508.

20. "3-D Surface Anthropometry: Review of Technologies." In Robinette KM, Vannierm MW, Rioux M, Jones PRM (Eds.) Working Group 20 of the Aerospace Medical Panel of the *Advisory Group for Aerospace Research & Development*, AGARD Advisory Report 329. Neuilly-Sur-Seine, France: 1997 Dec.

21. Young JW, Chandler RF, and Snow CC. *Anthropometric and Mass Distribution Characteristics of the Adult Female*, Oklahoma City OK: Civil Aeromedical Institute; 1983, Report No. FAA-AM-83-16, 1983.

Intentionally blank.

APPENDIX

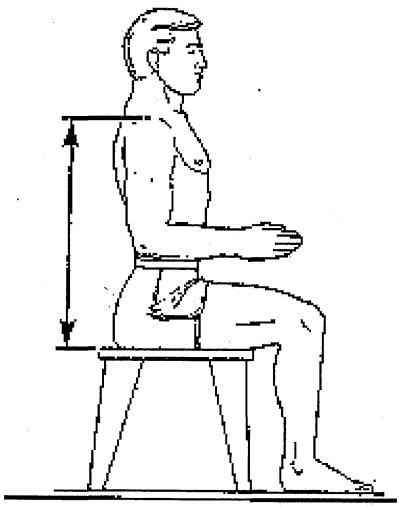
Definitions of Anthropometric Measurements[2]

[2] From: Gordon CC, Churchill T, Clauser CE, Bradtmiller B, McConville JT, Tebbetts I, and Walker R. 1988 *Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics*, Yellow Springs, OH: Anthropology Research Project, Inc.; 1989 Sep, Report No. NATICK/TR-89/044.

Intentionally blank.

ACROMIAL HEIGHT, SITTING

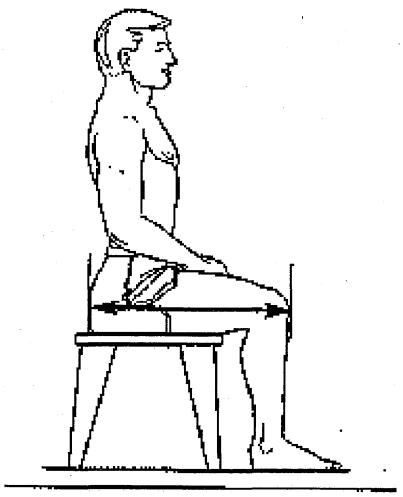
The vertical distance between a sitting surface and the acromion[a] landmark on the tip of the right shoulder is measured with an anthropometer. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed, and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are parallel, and the knees are flexed 90 deg with the feet in line with the thighs. The measurement is made at the maximum point of quiet respiration.



[a] Defined as the point of intersection of the lateral border of the acromial process and a line running down the middle of the shoulder from the neck to the tip of the shoulder.

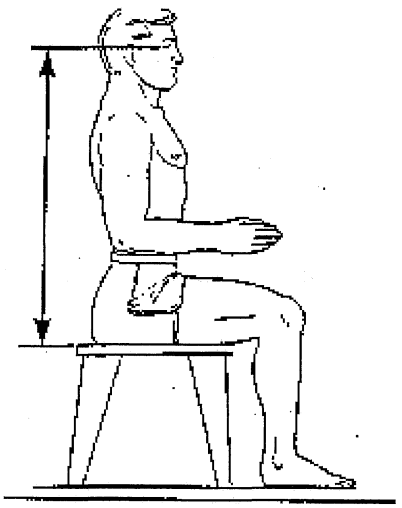
BUTTOCK-KNEE LENGTH

The horizontal distance between a buttock plate placed at the most posterior point on the buttock and the anterior point of the right knee is measured with an anthropometer. The subject sits erect. The thighs are parallel, and the knees flexed 90 deg with the feet in line with the thighs.



EYE HEIGHT, SITTING

The vertical distance between a sitting surface and the ectocanthuus[b] landmark on the outer corner of the right eye is measured with an anthropometer. The shoulders and upper arms are relaxed, and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are parallel and the knees are flexed 90 deg with the feet in line with the thighs. The measurement is made at the maximum point of quiet respiration.

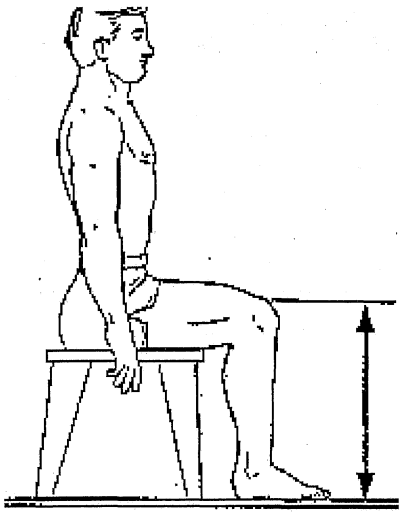


[b] Defined as the outside corner of the right eye formed by the meeting of the upper and lower eyelids.

KNEE HEIGHT

The vertical distance between a footrest surface and the suprapetella[c] landmark at the top of the right knee (located and drawn while the subject stands) is measured with an anthropometer. The subject sits with the thighs parallel, the knees flexed at 90 deg, and the feet in line with the thighs.

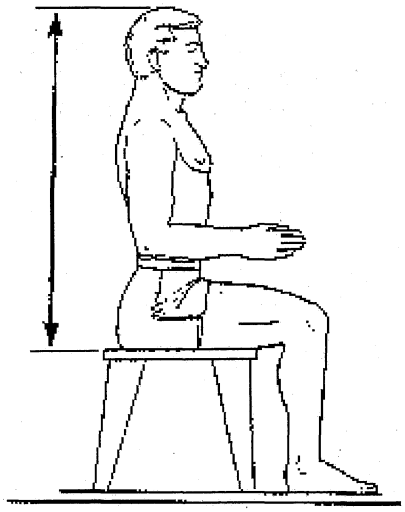
[c] Defined as the superior point of the right patella (kneecap).



SITTING HEIGHT

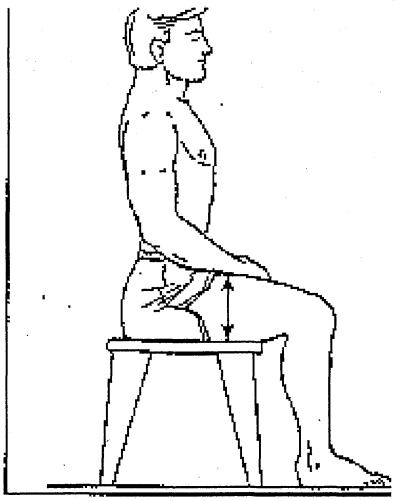
The vertical distance between a sitting surface and the top of the head is measured with an anthropometer. The subject sits erect with the head in the Frankfort Plane[d]. The shoulders and upper arms are relaxed, and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are parallel, and the knees are flexed 90 deg with the feet in line with the thighs. The measurement is made at the maximum point of quiet respiration.

[d] Defined as the standard horizontal plane or orientation of the head. The plane is established by a line passing through the right tragion (approximate ear hole) and the lowest point of the right orbit (eye socket).



THIGH CLEARANCE

The vertical distance between a sitting surface and the highest point on the top of the right thigh is measured with an anthropometer. The subject sits with the thighs parallel, the knees flexed 90 deg, and the feet in line with the thighs.



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	30 Jan 2001	

4. TITLE AND SUBTITLE
Digital Anthropometric Video-Imaging Device (DAVID) Versus Anthropometer Measurements

5. FUNDING NUMBERS
63706N 7907

6. AUTHOR(S)
J. L. Saxton, C. L. Lords, and F. R. Patterson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Aerospace Medical Research Laboratory
51 Hovey Road
Pensacola, FL 32508-1046

8. PERFORMING ORGANIZATION REPORT NUMBER
NAMRL-1413

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
Ball Tower One
800 N Quincy Street
Arlington, VA 22217-5660

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

Anthropometric data are essential in the development and design of items in industry, transportation, and housing. Anthropometry is particularly important in military aviation due to restrictive environments found in cockpits and the limited range of motion allowed for safe operation of controls. Methods of obtaining anthropometric measurements are varied; they range from manual techniques, such as tape measures and calipers to three-dimensional whole-body scanners. In addition to these methods, a computer-based technique called the digital anthropometric video-imaging device (DAVID) has been developed at the Naval Aerospace Medical Research Laboratory, in Pensacola, Florida. The DAVID provides a means to capture and measure a person's digital image using off-the-shelf hardware and software. A study comparing 6 anthropometric measurements (sitting height, sitting eye height, sitting acromial height, thigh clearance, buttock/knee length, and sitting knee height) was completed on 236 aviation candidates (200 males and 36 females) using both the DAVID and manual (anthropometer) measurement methods. The mean data measurements compared favorably with data reported in previous anthropometric surveys. The results of this study indicate the DAVID technology provides comparative results to standard manual methods for the measurements tested.

14. SUBJECT TERMS
DAVID Anthropometric Measurements
Anthropometry Digital Anthropometric Video-Imaging Device

15. NUMBER OF PAGES
17

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

Reviewed and approved 30 JAN 01

R. R. STANNY, Ph.D.
Technical Director

This research was sponsored by the Office of Naval Research under task number 63706N 7907.

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

Volunteer subjects were recruited, evaluated, and employed in accordance with the procedures specified in the Department of Defense Directive 3216.2 and Secretary of the Navy Instruction 3900.39 series. These instructions are based upon voluntary informed consent and meet or exceed the provisions of prevailing national and international guidelines

Trade names of materials and/or products of commercial or nongovernment organizations are cited as needed for precision. These citations do not constitute official endorsement or approval of the use of such commercial materials and/or products.